International Journal of Engineering and Technical Research (IJETR)
ISSN: 2321-0869, Volume-3, Issue-5, May 2015

Brain Tumor Extraction from MRI images using a hybridized method of K means Clustering, Watershed segmentation and Morphological operations

Shradha Sharma, Divyank Tambi, Mrs. Shefali Sharma

***Abstract*—Brain tumor is an uncontrolled growth of tissues in human brain. This tumor, when turns in to cancer becomes life-threatening. For images of human brain different techniques are used to capture image. These techniques involve X-Ray, Computer Tomography (CT) and Magnetic Resonance imaging MRI. For diagnosis, MRI is used to distinguish pathologic tissue from normal tissue, especially for brain related disorders and has more advantages over other techniques. The fundamental aspect that makes segmentation of medical images difficult is the complexity and variability of the anatomy that is being imaged. It may not be possible to locate certain structures without detailed anatomical knowledge. In this paper, a method to extract the brain tumor from the MRI image using clustering and watershed segmentation is proposed. The proposed method combines K-means clustering and watershed segmentation after applying some morphological operations for better results. The major advantage of watershed segmentation is that it is able to construct a complete division of the image but the disadvantages are over segmentation and sensitivity which was overcome by using K-means clustering to produce a primary segmentation of the image.**

***Index Terms*—Magnetic Resonance Imaging (MRI),K-means clustering, watershed segmentation.**

I. Introduction

The main goal of brain tumor imaging is to extract the important clinical information, and their diagnostic features. Image segmentation is basically a method to partition an image into mutually exclusive regions such that each region is spatially contiguous and the pixels within each partitioned region are homogeneous according to a predefined criterion.[3]

The main advantage of MRI over CT scan is, it does not contain any radiation. So, MRI does not affect human body and has rare allergic reactions. MRI provide accurate visualizations of anatomical structure of tissues. CT scan is best suited for viewing hard tissues whereas MRI is more sensitive and specific in diagnosing soft tissues abnormalities.

MRI can produce images in any plane, even 3D and isotropic imaging can also be done.

Shradha Sharma, Student , ECE department, Jaypee University of Engineering and Technology, Guna, India

Divyank Tambi , Student , ECE department, Jaypee University of Engineering and Technology, Guna, India

Mrs. Shefali Sharma, Assistant Professor, ECE department, Jaypee University of Engineering and technology, Guna, India

From the MRI images the information such as tumors location provides radiologists, an easy way to diagnose the tumor and plan the surgical approach early. [2]

Brain tumor segmentation consists of separating the different tumor tissues such as solid or active tumor, edema, and necrosis, from normal brain tissues, such as gray matter (GM), white matter (WM) and cerebrospinal fluid (CSF) as shown in figure 1.

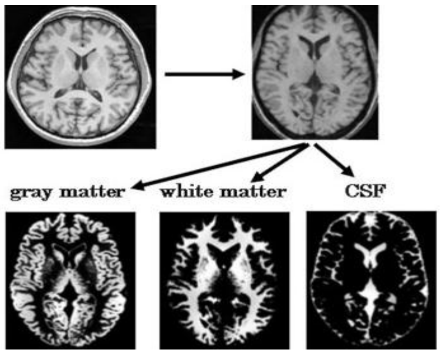

Figure 1: Types of Brain Tissues

.

II. Related Works

Brain tumor segmentation and pattern recognition is an important research field used in computer vision and image processing.

Many methods related to brain tumor segmentation were studied. A report of the Literature survey is presented here. Evelin Sujji et al compared global and local thresholding based tumor segmentation methods and concluded that global thresholding is simple and faster in computation time only if the image has homogeneous intensity and high contrast between foreground and background whereas local thresholding method can process uneven illumination also.[4] In order to obtain sharp results , which was a well observed drawback of thresholding technique, the region based segmentation method which is used to extract a connected region of similar pixels from an image was studied. As a part of region based focus was on texture based and Intensity based segmentation. In intensity based method gap observed was of non-homogeneity in images [3].Viji et al introduced a modified texture based method using texture units where heterogeneous and irregular tumor pattern of different intensities can also be distinguished[5].Salman et al used watershed segmentation for detection of tumor and this method had the advantage of detecting corners of tumor accurately. But at the same time, it suffered from the problem of over segmentation. So, there was a need of pre-segmentation before application of watershed segmentation .Pixel based approach of segmentation with focus on k-means clustering was studied, which in itself had some drawbacks like selection of initial centroid values which produced variable results[3]. Thus in the proposed method watershed and k-means were used to avoid the problems faced. K-means clustering was used which formed clusters hence dividing the image in less number of gray levels. The brightest cluster was obtained and watershed segmentation was applied after some morphological operations.

III. Methodology

This paper mainly consists of two methods: K means clustering followed by watershed segmentation method. Kmeans clustering method helps to pre-segment the brain tumor image and the second method improves the results of segmentation of tumor by defining the boundaries of the tumor.

A. *Pre-processing*

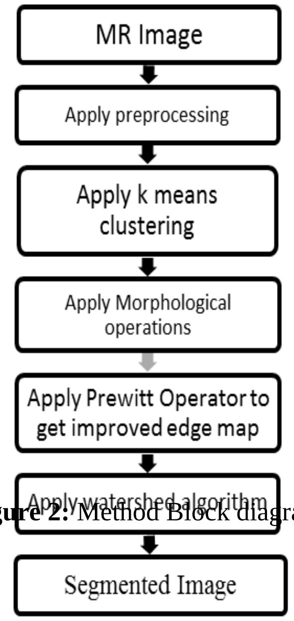

Figure 2: Method Block diagram

Pre-processing step consists of noise reduction and image enhancement. MRI images contain thermal noise, salt and pepper noise and Gaussian noise .To remove different noises we require different types of filter. The method of removing the noise from the original image is known as Denoising. It is important to remove the noise from the MRI images before applying the segmentation methods as the presence of noise degrades the performance and accurate results are to be obtained for correct diagnosis by clinical methods which will aid the doctors to perform the operation successfully. Noise removal will also increase the SNR and quality of the image which helps in getting better segmented image.

Average filter and median filters were used to remove the additive and salt & pepper noise respectively.

B. *K-means clustering*

Kmeans clustering is an unsupervised algorithm that divides the image pixels into various clusters based on some similarity criterion such as minimum difference between the pixel value and the cluster centers. It divides the pixels into 'K' number of clusters that is a predefined parameter.

The K-means clustering applied in this paper has a value of k=4, as there are around 4 types of tissues in brain namely Gray matter(GM), white matter(WM), Cerebrospinal fluid (CSF) and the tumor tissues with varying intensity values.

The algorithm involves the following steps.

Step 1: Choose a suitable number of clusters (say 'k').

Step 2: Set initial centers of clusters as c1, c2… ck.

Step 3: Every single pixel is compared to all cluster centers using minimum distance criterion. The pixel is moved to the particular cluster which has the shortest distance among all.

Step 4: Cluster centers are recomputed.

Step 5: If cluster centers change, then go to Step 3 else end the process. [7]

After the clustering process, the brightest cluster is selected assuming that the tumor cells are always have more intensity than the normal brain tissues and hence will always belong to the brightest cluster. A binary image is created containing only the brightest cluster. The clustered image is shown in figure and the image with brightest cluster is shown in figure .

C. *Morphological Operations*

Hole filling is done to remove the black spots present inside the white part of the brightest cluster if any are present. Another operation known as erosion followed by dilation is applied to remove the small spots which are not the part of the tumor.

D. *Watershed Segmentation*

Water shed segmentation is done on the intensity bases. As every pixel has different intensity compared to each other, the pixels are grouped based on their intensities and the region is grown until there is a point where the two catchment basins meet and a watershed ridgeline is the created at these points.

The following steps used in watershed algorithm [6]:

Step 1: Read the Image and convert to gray scale.

Step 2: Compute gradient of image using Sobel operator.

Step 3: Find the topographic graph of gradient.

Step 4: Detect regional minima using distance transform.

Step 5: Start flooding every minima.

Step 6: Detect intersection point where flood meet.

Step 7: Erect watershed.

After the watershed segmentation of the image is obtained a labeled output is created to mark various regions created by the watershed ridge lines. It is then overlaid with the original image to show the extracted tumor as shown in figure 7.

IV. RESULTS

The results obtained are shown in figures (3-8).The clustered image as shown in figure 4 contains four clusters out of which the brightest cluster contains the tumor region.

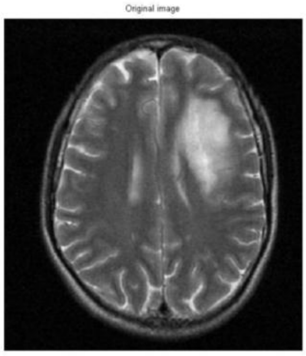

Figure 3: Original MRI Image

Figure 4: After K-means Clustering (k=4)

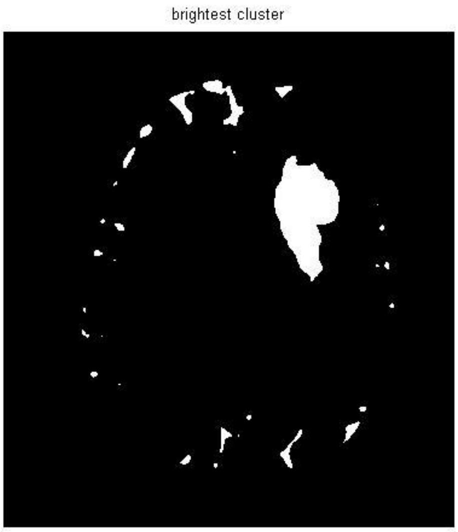

Figure 5: Brightest Cluster

The brightest cluster is shown in Figure 5. After applying hole-filling and other morphological operation the result is shown in Figure 6.

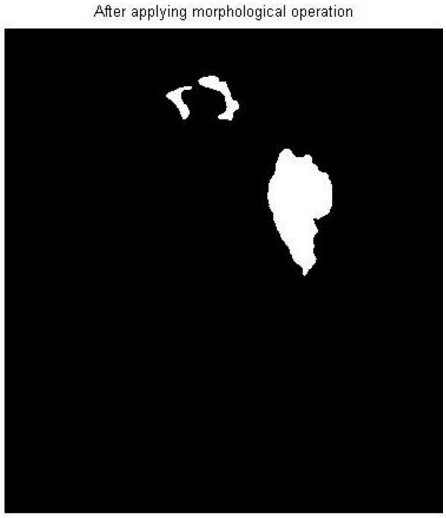

Figure 6: Extracted tumor after morphological operations

After applying watershed on the extracted tumor the watershed output and overlaid watershed labeled output are shown in figure 7 and figure 8.

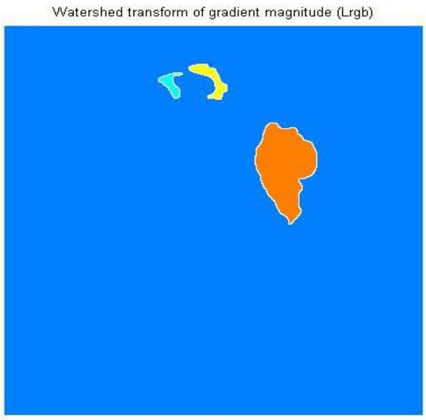

Figure 7: Labeled watershed output

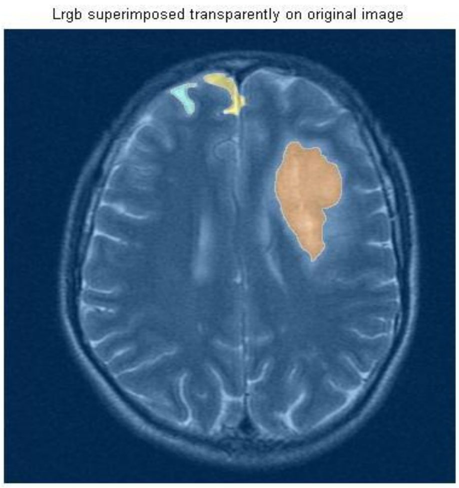

Figure 8: Labeled watershed output

V. CONCLUSION

Many segmentation techniques have been studied to achieve ameliorated results of Brain Tumor MRI images. Using these approaches extraction of abnormal brain tissues can be done properly. First step was preprocessing and is important to get better results. We can see from the super imposed image that the tumor is well extracted. In the future, we can also study the growth of tumor by plotting a graph between tumor size and time by segmenting sequential images of tumor affected person's brain.

REFERENCES

[1] Gauri P. Anandgaonkar1, Ganesh.S.Sable , "Detection and Identification of Brain Tumor in Brain MR Images Using Fuzzy C-Means Segmentation", International Journal of Advanced Research in Computer and Communication Engineering, Vol. 2, no. 10, pg. 2319-2325, October 2013.

[2] Saif D. Salman & Ahmed A. Bahrani , " Segmentation of tumor tissue in gray medical images using watershed transformation method", International Journal of Advancements in Computing Technology, Vol. 2, no. 4, pg. 3542-3548, October 2010.

[3] Nelly Gordillo , Eduard Montseny and Pilar Sobrevilla , "State of the art survey on MRI brain tumor segmentation", Magnetic Resonance Imaging ,Vol. 8, no. 6, pg. 641-647, 2013.

[4] G. Evelin Sujji, Y.V.S. Lakshmi, G. Wiselin Jiji3, "MRI Brain Image Segmentation based on Thresholding", International Journal of Advanced Computer Research , Vol. 8, no. 6, pg. 1010-1024, 2013.

[5] K. S. Angel Viji, Dr J. Jayakumari ,"Modified Texture Based Region Growing Segmentation of MR Brain Images", IEEE Conference on Information and Communication Technologies ,Vol. 9, no. 7, pg. 1159-1165, April 2013.

[6] M.C. Jobin Christ ,Dr. R.M.S. Parvathi "MAGNETIC RESONANCE BRAIN IMAGE SEGMENTATION", International Journal of VLSI design & Communication Systems (VLSICS), Vol.3, no.4, pg. 800-810 , 2014.

[7] Kailash Sinha, G.R. Sinha, "Efficient Segmentation Methods for Tumor Detection in MRI Images" , *IEEE Student's Conference on Electrical, Electronics and Computer Science* ,Vol. 8, no. 6, pg. 314-325, 2014.

[8] B.K. Saptalakar, Rajeshwari.H, "Segmentation Based Detection Of Brain Tumor", *International Journal of Computer and Electronics Research*, Vol. 2, issue 1, pg. 1563-1580, February 2013